

The method of treatment adopted by the author is one likely to be very effective in teaching; new principles and processes, as they arise in the natural development of the subject, are illustrated and driven home by the use of models, diagrams, and repeated applications to suitable problems, so that the conscientious student is always fully conversant with the reasons for his geometrical constructions. The very excellent and suggestive questions from the examination papers of the Board of Education for the last five or six years are freely employed, both in the text and as sample test papers, affording a good criterion of progress.

In addition to the ordinary geometrical solids, many familiar objects the forms of which can be dissected into simple geometrical figures are used as examples. After the student has thoroughly mastered the fundamental principles as set forth in part i., he should experience comparatively little difficulty with the three succeeding parts, which extend the subject to lines and planes obliquely situated, to shadows by parallel and divergent rays, and to reflections in horizontal and vertical mirrors. The book will be very acceptable both to teachers and students of this interesting branch of applied geometry.

Strength of Materials. By W. C. Popplewell. Pp. x+180. (Edinburgh and London: Oliver and Boyd, 1907.)

THIS text-book, which is based on the notes of lectures given by the author to day and evening students at the Manchester Municipal School of Technology, deals with the fundamental principles which must be mastered by every student who wishes to have a sound knowledge of machine and structural design. Special attention has been devoted to the effects of unequal distribution of stress, and in chapter vii. the author gives details of his own experimental work in connection with this branch of the subject. The last three chapters give an account of the methods adopted and appliances required in making tests of the various materials used in constructional work, and the important subjects of limit of elasticity and of the influence of previous loading, &c., upon the limit are discussed. In an appendix is given a table of strengths and weights of a large number of different materials, and there is a collection of useful examination questions for each chapter.

LETTERS TO THE EDITOR.

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Lithium in Radio-active Minerals.

THE recent results of Mlle. Gleditsch (*Comptes rendus*, cxlvi., p. 331) corroborating those of Prof. McCoy, viz. that lithium is generally, but not always, a constituent of radio-active minerals containing copper, and that there is no fixed proportionality between the copper and the lithium in these minerals, must not be taken to have the exclusive significance which their authors attribute to them. As explained in our original communication to the Chemical Society, we are inclined to believe that sodium, and perhaps also potassium, are products of the degradation of copper salts when in contact with radium emanation. As both these metals are constituents of ordinary glass, and as the experiments were carried out in glass vessels, the only argument which was used was that the weight of the residue from the treated was greater than that from the untreated copper salt. Lithium was mentioned because it is an unlikely constituent of dust, glass, copper, &c., which were tested specially to prove its absence; it was certainly contained in the treated residue. Inasmuch as

the emanation in contact with water yields neon, on the probable supposition that monatomic gases are produced from the emanation, it would follow that the production of any particular one is dependent on surrounding conditions. It will be remembered that the gases from the action of the emanation on a solution of copper sulphate contained no helium, but probably argon. As sodium and potassium are much more widely distributed than lithium, it is more likely that they are the chief products from copper, and that some modifying circumstance has determined the formation of a trace of lithium. Experiments now in progress in silica vessels will settle this point. Numerous chemical analogies might be adduced in favour of this view. For example, the action of bleaching powder on ammonia solution is to give nitrogen for the most part; if much ammonia be present, and if glue or some other colloid be present, hydrazine is the chief product. One can only be guided by such analogies in determining the lines of future experiments.

W. RAMSAY.

Formation of Ground-ice.

IN Canada we have made an extended study of the formation of ground-ice, or anchor-ice as it is called here, and consequently I was interested to see a letter in NATURE of January 30 from Mr. Hampson asking for information as to its origin.

May I at the outset refer Mr. Hampson to four papers published many years ago which are wonderfully interesting to anyone studying the formation of ground-ice? Two of the papers appeared in the *Edinburgh New Philosophical Journal*, one by M. Arago, vol. xv., p. 123, 1833, and the other by the Rev. Mr. Eisdale, vol. xvii., p. 167, 1834. The two other papers were published in the *Phil. Trans.*, vol. cxxv., p. 329, 1835, and vol. cxxxi., p. 37, 1841, by the Rev. James Farquharson, of Alford.

In reply to the questions raised by Mr. Hampson, I may say that (1) the essential conditions for the formation of ground-ice on the bed of a river are clear weather conditions at night with the water at or near the freezing point, excessively low air temperatures by day, with no sunshine and no surface ice or other cover such as overhanging weeds or a bridge to check the nocturnal radiations. The answer to (2) is covered by the above. (3) A flowing river becomes stirred by eddy currents, and hence the cold surface layers find their way to the bottom. We notice many of our large rivers flow with a rolling motion. (4) The water is such a bad conductor of heat that it is only by the mechanical action that the bed of a river becomes cold enough to form ice on it when aided by radiation, or, as I have shown, by a slight supercooling in the water. (5) Ground-ice will form in water of any degree of agitation provided either or both of the causes mentioned in (4) are operating. In the case Mr. Hampson cites of the mill, I should say the heat generated by the water flowing through the mill would tend to prevent the formation of ice on the lower side.

In Canada we have anchor-ice formed in very large quantities in all the waterways flowing too swiftly for surface-ice to form. In some parts of the St. Lawrence it grows 5 feet or 6 feet in depth, forming very rapidly during the periods of intense cold and clear nights. On bright days the sun's radiant heat brings large quantities of it to the surface with much noise and disturbance. The buoyancy of large masses of the ice is often great enough to raise huge stones and boulders and carry them along in the current, depositing by this means portions of the river bed further down stream in the quieter waters. Boatmen are very careful not to cross the river when anchor-ice is rising, for fear of having a large mass come up under them and carry the boat helpless into the rapids. Under surface-ice, with its covering of opaque snow crystals, anchor-ice does not form, and hence it causes no trouble under these conditions.

Anchor-ice is known and studied in every country in the world where ice is formed, and there is much that might be written about it. In NATURE of January 17, 1907, a careful review of my book on "Ice Formation," with special reference to anchor-ice and frazil, was given, and may help to answer some of the questions in the "long list" mentioned by Mr. Hampson. My paper read

before Section G at the Leicester meeting of the British Association, and published with illustrations in *Engineering* for August, 1907, will convey some idea of the ice problem as presented to the users of "white coal" in Canada. In Russia, M. Wladimirov has published several important papers on his studies of the ice conditions on the Neva, in connection with the Waterworks Commission of St. Petersburg. One thing is well established, and that is that the formation of natural ice such as ground-ice, whether in Great Britain, Canada, Russia, France, Germany or elsewhere, conforms to the known laws of nature. Not a single known case of natural ice formation has ever come under my notice which has not its possible duplication in a laboratory experiment. The two differ only in the magnitude of their effects.

H. T. BARNES.

McGill University, Montreal, February 10.

The Possibility of Life on Mars

MR. DINES's important letter on the "Isothermal Layer of the Atmosphere" has obviously an important bearing on the question of the gases that have been retained or lost by the atmosphere of Mars. If the temperature of our atmosphere ceases to decrease when a height averaging 35,000 feet is reached, and then remains practically constant at an average temperature of -47° C. whatever height be attained, we may expect somewhat similar conditions to prevail in the atmosphere of Mars, and naturally ask what are the temperatures which will allow of the escape of the different gases.

This question can be easily answered by a brief calculation from the data furnished on pp. 113 and 325 of Jeans's "Dynamical Theory of Gases" (1904). We find that at a temperature of -175° C. hydrogen will be "certainly retained," while at -65° C. it will be "certainly lost." The corresponding temperatures for helium will be -81° C. and 136° C., and for water vapour 599° C. and 1583° C. From these figures it results that if the temperature of the isothermal layer of Mars be the same as the temperature of that of our atmosphere, hydrogen will be lost, helium probably retained, and water vapour clearly retained. I should imagine that in the case of Mars the isothermal layer will be much colder, especially as the carbonic acid that is present in the atmosphere of that planet will be concentrated in the lower levels.

Neither Prof. Lowell nor Dr. Russel Wallace appear quite to have realised the importance of the influence of carbonic acid on the atmospheric temperature at the surface of the planet.

It is now a commonplace of geology that a variation in the small percentage of carbonic acid in the earth's atmosphere will have an important effect on the temperature of the latter, though authorities differ as to the numerical amount of the variation required to produce a given change of temperature under given conditions. If the atmosphere contains a relatively large amount of carbonic acid, a correspondingly greater proportion of the heat received will be retained, and the temperature will be higher. Such conditions will be marked by luxuriant vegetation, and at the same time rapid formation of carbonates by the action of water containing carbonic acid on silicates and other minerals. This will eventuate in a period when there is less carbonic acid in the air, and colder conditions will prevail. The growth of vegetation and the decomposition of minerals will be checked and confined to the warmer portions of the earth's surface. The supplies of carbonic acid from intratelluric sources will then gradually add to the amount of carbonic acid in the atmosphere, bringing an increase in temperature with it.¹ There are features in the geological record which lend support to the view that such a cycle of changes has occurred more than once in the earth's history.

If, now, we make the very reasonable assumption that the crust of Mars is composed of the same minerals as those with which we are familiar, and its atmosphere of the same gases as ours, and that accessions of carbonic

¹ I have stated the theory in its simplest terms. There are other circumstances that affect the amount of carbonic acid in the air. Prof. Chamberlin believes that the sea plays an important part in absorbing or giving out the gas according to the conditions that prevail.

acid are received from the interior of the planet, we may expect a similar automatic adjustment of the temperature so that it is never too cold for the chemical reactions of carbonic acid in solution to take place, and for vegetation, such as that believed to exist by Prof. Lowell, to maintain itself somewhere on the surface of the planet. The amount of carbonic acid required for the purpose will, of course, be greater than that in our atmosphere, but there is no reason to believe that it would reach an amount which would be injurious to the life of plants or animals, even if such were similar in nature to those on the earth.

Whether Prof. Lowell can be considered to have established his views is a question on which I do not feel called upon to express an opinion, but I confess that the arguments advanced against them do not strike me as convincing. They remind me of those of the engineers who satisfied themselves that a locomotive could not draw a train of trucks on smooth rails, and were not persuaded to the contrary until they saw that it did so.

Imperial Institute, February 28.

J. W. EVANS.

A Fundamental Contradiction between the Electrical Theory of Dispersion and the Phenomena of Spectrum-series.

THE electrical theory of dispersion is based on the hypotheses (1) that electric waves are due to motions of electric charges, and waves of light in particular to vibrations of charges inside the atom; and (2) that these vibrations are governed by linear equations. On this basis we obtain the usual dispersion formulæ, e.g. that of Drude:—

$$n^2 - 1 = \sum \frac{N_h e_h^2}{\pi m_h} \frac{\lambda_h^2}{1 - \lambda_h^2/\lambda^2},$$

where n is the refractive index for wave-length λ , λ_h one of the free periods of a set of electrons in the atom, e_h the charge, m_h the mass, and N_h the number per c.c. of the electrons of the set, while the summation is for all possible free periods of the atom. In particular, if λ be greater than every one of the free wave-lengths of the atom, we get

$$n^2 - 1 > \sum \frac{N_h e_h^2 \lambda_h^2}{\pi m_h}.$$

Consider the contribution of all the lines of the well-known Balmer series to the dispersion of hydrogen; for this series

$$\lambda_h = \lambda_{\infty} \frac{m^2}{m^2 - 4}, \quad m = 3, 4, \dots, \infty,$$

where

$$\lambda_{\infty} = 3646 \cdot 13 \text{ A.U.}$$

Its contribution exceeds

$$\sum_{m=3}^{\infty} \frac{N_h e_h^2 \lambda_h^2}{\pi m_h} \frac{m^4}{(m^2 - 4)^2}.$$

If the theory is to account for the lines of the series at all, the factor $N_h e_h^2 \lambda_h^2 / \pi m_h$ cannot vanish for any line; let A be its least value. Then the contribution exceeds

$$A \sum_{m=3}^{\infty} \frac{m^4}{(m^2 - 4)^2}.$$

The sum is obviously infinite; but all experience shows that for long waves the refractive index of hydrogen is nearly unity, and finite even for luminous hydrogen.

The same result follows for any series formula which implies that a series has (1) a tail; (2) an infinite number of lines the wave-length of which exceeds that of the tail, that is, for all known formulæ which agree with measurements either of line or of band series.

Thus we must either reject the usual notion of a series, and with it all the formulæ which represent our experience best, or we must reject the hypothesis that series lines are due to small vibrations of electric charges governed by linear equations, and with it the usual theories of dispersion and absorption, of the Zeeman effect and of magnetic rotation for series lines.

G. A. SCHOTT.

Physical Institute, Bonn, February 17.